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Lake Erie Bottom Trawl Explorations, 1962-66

EDGAR W. BOWMAN

ATTLE, WA
UARY 1974

National Marine Fisheries Service, Special Scientific Report--Fisheries Series

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SEATTLE, WA
JANUARY 1974

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CONTENTS

	Page
Introduction	1
Vessel, gear, and methods	1
Fishing effort	3
Species composition of trawl catches	4
Discussion by basin	5
Western Basin	5
Central Basin	8
Eastern Basin	9
Discussion by species	11
Yellow perch	11
Rainbow smelt	11
Alewife	12
Freshwater drum	12
Carp	12
Gizzard shad	12
Miscellaneous species	12
Summary and conclusions	12
Literature cited	13

Figures

1. The Great Lakes RV *Kaho* of the Bureau of Commercial Fisheries Branch of Exploratory Fishing and Gear Research 2
2. Fishing sites occupied by RV *Kaho* during 1962 Lake Erie explorations (Cruises 2 and 4) ... 3
3. Fishing sites occupied by RV *Kaho* during 1963 and 1966 Lake Erie explorations (Cruises 11 and 36) 3
4. Map of Lake Erie showing basins and geographic locations mentioned throughout text 4
5. Percentage species composition of alewife, smelt, and yellow perch in exploratory trawl catches by basin and year in Lake Erie 5
6. Species composition of exploratory trawl catches by year in Lake Erie 5
7. Typical mixed catch of Lake Erie fish from the western basin; catch was dominated by carp, sheepshead, yellow perch, and alewife 8
8. Typical catch of fish from the central basin of Lake Erie, consisting of nearly equal amounts of yellow perch, smelt, and alewife 10
9. Typical catch of fish from the eastern basin of Lake Erie. Catch was composed of about 75% smelt and 25% alewife 11

Table

1. Species composition of 245 trawl catches by RV *Kaho* in Lake Erie, 1962-66 6

Appendix Tables

1. RV *Kaho* fishing log—trawl stations in the Western Basin of Lake Erie..... 14
2. RV *Kaho* fishing log—trawl stations in the Central Basin of Lake Erie 15
3. RV *Kaho* fishing log—trawl stations in the Eastern Basin of Lake Erie 17

4. Species composition of 56 trawl catches by RV *Kaho* in Lake Erie during Cruise 2, May 1962 18
5. Species composition of 55 trawl catches by RV *Kaho* in Lake Erie during Cruise 4, September 1962 19
6. Species composition of 87 trawl catches by RV *Kaho* in Lake Erie during Cruise 11, May 1963 20
7. Species composition of 47 trawl catches by RV *Kaho* in Lake Erie during Cruise 36, October 1966 21

Lake Erie Bottom Trawl Explorations, 1962-66

EDGAR W. BOWMAN[1]

ABSTRACT

The Bureau of Commercial Fisheries (now the National Marine Fisheries Service) Exploratory Fishing and Gear Research Base, at Ann Arbor, Mich., surveyed the abundance, availability to the otter (bottom) trawl, and depth distribution of various Lake Erie fish stocks between April 1962 and October 1966. The four exploratory cruises, conducted aboard the research vessel *Kaho,* clearly demonstrated the effectiveness of the bottom trawl in producing commercial quantities of yellow perch, *Perca flavescens,* and rainbow smelt, *Osmerus mordax.* Freshwater drum, *Aplodinotus grunniens;* carp, *Cyprinus carpio;* channel catfish, *Ictalurus punctatus;* and white bass, *Roccus chrysops,* were all produced in commercial quantities at least once during the study and collectively accounted for 17.1% of the total landings.

Between the first exploratory cruise in 1962 and the last in 1966 the abundance of yellow perch decreased significantly, and that of alewife, *Alosa pseudoharengus,* increased dramatically.

INTRODUCTION

A gradual population shift in Lake Erie fisheries has led to commercial extinction of many highly prized species. Lake herring, *Coregonus artedii,* has ceased to be a factor in the commercial catch statistics for Lake Erie after 1947 and can now be considered to be commercially extinct. Blue pike, *Stizostedion vitreum glaucum,* have declined to the point where in 1964 less than 500 pounds were reported taken by U.S. and Canadian fishermen. The population of sauger, *S. canadense,* declined drastically between 1946 and 1958 and may now be nearing biological extinction. For years annual production of lake whitefish, *Coregonus clupeaformis,* fluctuated between 1 and 7 million pounds but in 1955 landings began to decline sharply. Less than 3,000 pounds were landed by U.S. fishermen in 1966.

In 1958, the Bureau of Commercial Fisheries began exploratory fishing to find possible alternate commercial species in Lake Erie; explorations through 1959 demonstrated the effectiveness of the bottom trawl in taking commercial quantities of rainbow smelt, *Osmerus mordax,* and provided information concerning the distribution of smelt by area, season, and depth (Sand and Gordon, 1960). Succeeding explorations in 1960 (Carr, 1964) added to the 1958 and 1959 findings and indicated species other than smelt were also available to bottom trawls.

During the period 1962-66, seven major food species in Lake Erie made up the bulk of the annual catch: walleye, *Stizostedion vitreum vitreum;* yellow perch, *Perca flavescens;* rainbow smelt; freshwater drum, *Aplodinotus grunniens;* white bass, *Roccus chrysops;* channel catfish, *Ictalurus punctatus;* and carp, *Cyprinus carpio.*

This study is based on two exploratory cruises undertaken in 1962 and one cruise each in 1963 and 1966. The data collected, together with previously gathered data 1) document for the record the fishery population available in Lake Erie between 1962 and 1966 and 2) offer a baseline for future comparison studies of species abundance and composition.

VESSEL, GEAR, AND METHODS

The Department of the Interior research vessel *Kaho* (Fig. 1) was used for all exploratory fishing operations. Launched in 1961, the RV *Kaho* is of steel and aluminum construction, is approximately 65 ft. long, has a 17¾-ft beam and a loaded draft of 8 ft. The vessel is rigged for stern trawling and is equipped with a "white line" echo sounder for defining bottom configurations and for detecting fish.

[1]Exploratory Fishing and Gear Research Base, Bureau of Commercial Fisheries, Ann Arbor, Mich.; present address: Northeast Fisheries Center, National Marine Fisheries Service, Woods Hole, MA 02543.

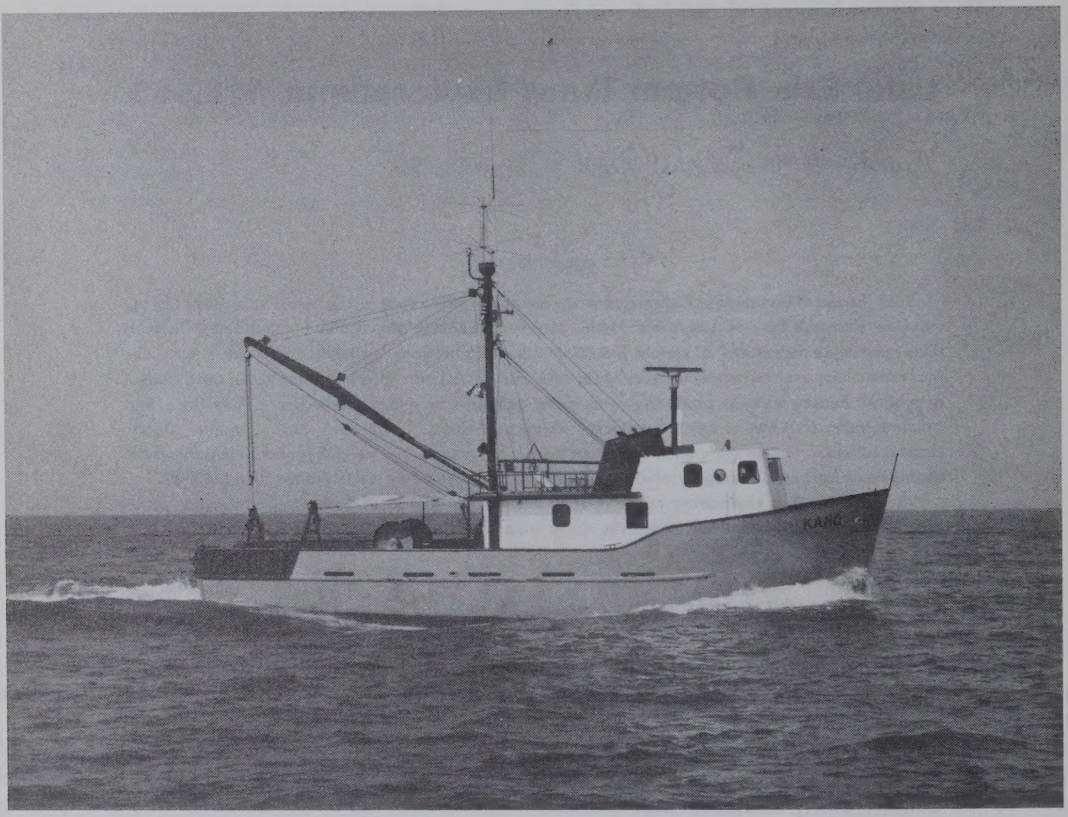

Figure 1.—The Great Lakes RV *Kaho* of the Bureau of Commercial Fisheries Branch of Exploratory Fishing and Gear Research.

All drags throughout this study were made with a 52-ft (headrope) Gulf-of-Mexico type, semi-balloon fish trawl described by Gordon and Brouillard (1961). An additional seven drags during Cruise 4 and eight drags during Cruise 11 were made for studies of mesh-size selectivity with a "trouser leg" cod end. The results of that study have been summarized by Reigle (1966).

Drags lasted 30 min, unless shortened because of rough bottom, snags, gear malfunctions, or stationary fishing gear (gill nets, pound nets, and trap nets) set within the area of operation. Dragging speeds averaged 2.5 miles per hour with the net held as closely as possible to a constant depth by dragging along the bottom contour. Catches were recorded by species and weight. Additional observations on weather, sea conditions, bottom conditions, and water temperature were recorded at all drag locations.

For this study, evaluations of fishing results are based on two methods of calculations: 1) Catch rate—which is pounds produced per unit effort for all drags in a particular evaluation and 2) average catch for effective fishing effort—which is pounds per unit effort for only those drags that contained the species being evaluated (Reigle 1969a, b). Effective fishing effort as well as the analysis of fishing statistics in the Great Lakes has been discussed by Hile (1962). All analyses of catch rate and average catch for effective fishing effort are based on a one-half hour of fishing time. Total fishing time was adjusted into ½-hr periods, thus drags, which were shorter than one-half hour due to snags or for other reasons, were adjusted and are included in all evaluations.

Prior to each survey cruise, fishing sites were selected in such a way as to provide information from representative areas over a range of depths

and bottom types. Drag locations, by cruise, have been plotted and are shown in Figures 2 and 3.

Exploratory cruises are numbered consecutively regardless of the area of operation; thus, the numbers designating Lake Erie cruises used in this paper are not in sequence.

Throughout this paper, a commercially significant catch will be defined as those catches having a gross ex-vessel value of $7.50 per ½-hr fishing time. The following ½-hr catch rates are considered to be commercially significant: yellow perch, 85 pounds; rainbow smelt, 150 pounds; freshwater drum, 375 pounds; carp, 220 pounds; channel catfish, 35 pounds; and white bass, 50 pounds.

FISHING EFFORT

The four cruises, 1962 through 1966, included fishing all three basins of Lake Erie. The operating time of 100 days accounted for 245 trawl drags (over 118 hr of fishing). To simplify further discussions, a brief description of each cruise, the geographical delineation of three basins of the lake, and the distribution of fishing effort follow.

The first Lake Erie cruise of this study (Cruise 2 of the *Kaho)* covered the 26 days from 25 April to 20 May 1962; 56 experimental 30-min drags were completed.

Cruise 4 (the second Lake Erie cruise) covered the 18 days from 23 September to 10 October 1962. Sixty-two experimental drags were completed, seven of which were made for the study of mesh-size selectivity and are not discussed in this paper. Three of the remaining 55 drags were cut short on account of snags and rough bottom.

Cruise 11 (the third Lake Erie cruise) covered the 29 days from 22 May to 20 June 1963. Eighty-seven exploratory drags were completed, six of which

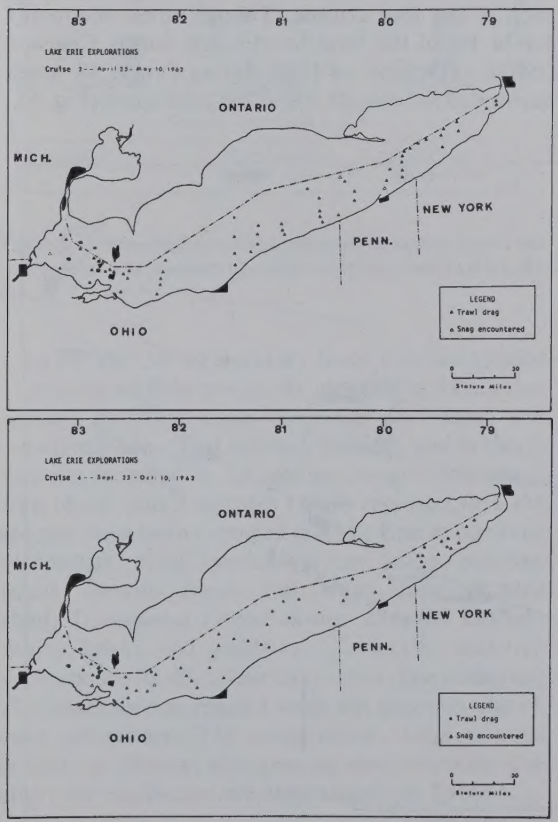

Figure 2.—Fishing sites occupied by RV *Kaho* during 1962 Lake Erie explorations (Cruises 2 and 4).

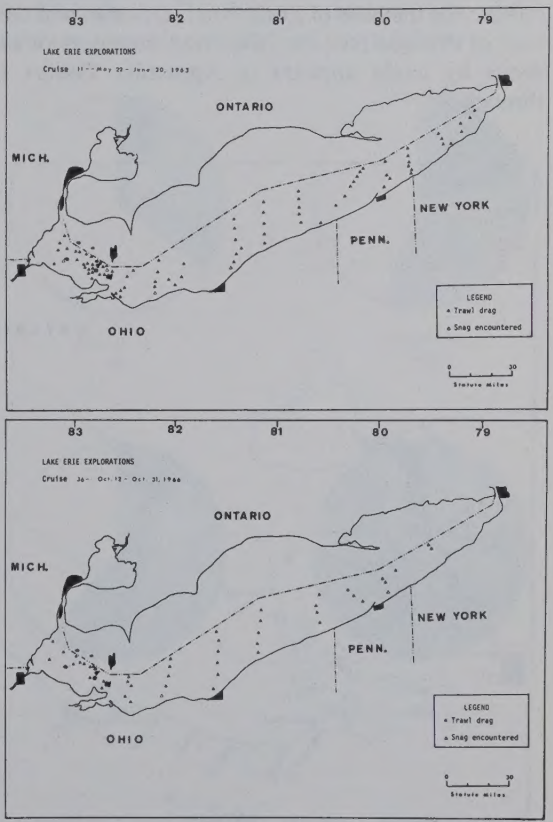

Figure 3.—Fishing sites occupied by RV *Kaho* during 1963 and 1966 Lake Erie explorations (Cruises 11 and 36).

were terminated early due to gear damage or to avoid bottom obstacles and gill nets.

Cruise 36 (the final cruise included in this study) covered the 20 days from 12 October to 31 October 1966. Forty-seven exploratory drags were completed, six of which were terminated early due to gear damage, gear malfunction, or total loss of the trawl.

The combined effort (245 drags used here) of all four exploratory cruises was distributed among the three basins of Lake Erie as follows:

Western Basin	60 drags
Central Basin	125 drags
Eastern Basin	60 drags

The Western Basin is separated from the Central Basin by an imaginary line connecting the tip of Point Pelee, Ontario, and the tip of Cedar Point, Ohio. The Eastern Basin begins at an imaginary line connecting the base of Long Point, Ontario, and the base of Presque Isle, Pa. (Fig. 4). A summary of all drags by basin appears in Appendix Tables 1 through 3.

SPECIES COMPOSITION OF TRAWL CATCHES

Results obtained from the data collected during the Lake Erie explorations serve to point out by basin and year the relative shift in species composition from 1962 to 1966 (Fig. 5). Appendix Tables 4 through 7 indicate species composition during each of the four cruises discussed in this paper.

The exceptionally good hatch of yellow perch in 1959 was evidently responsible for the dominance of this species in the 1962 and 1963 trawl catches (U.S. Fish and Wildlife Service, Region 4, 1966). Alewives were not taken in trawl catches at all during Cruise 2 (1962) and only in modest quantities during Cruises 4 (1962) and 11 (1963). In 1966, however, during Cruise 36, a sizable population was evident—alewives, *Alosa pseudoharengus,* accounted for 54.4% of the total catch. Rainbow smelt was the second most abundant species during each of the four cruises. Though smelt accounted for 34.4% of the total trawl catch during Cruise 4 (1962), in October of 1966, during Cruise 36, smelt accounted for only 23.9% of the total catch (Fig. 6).

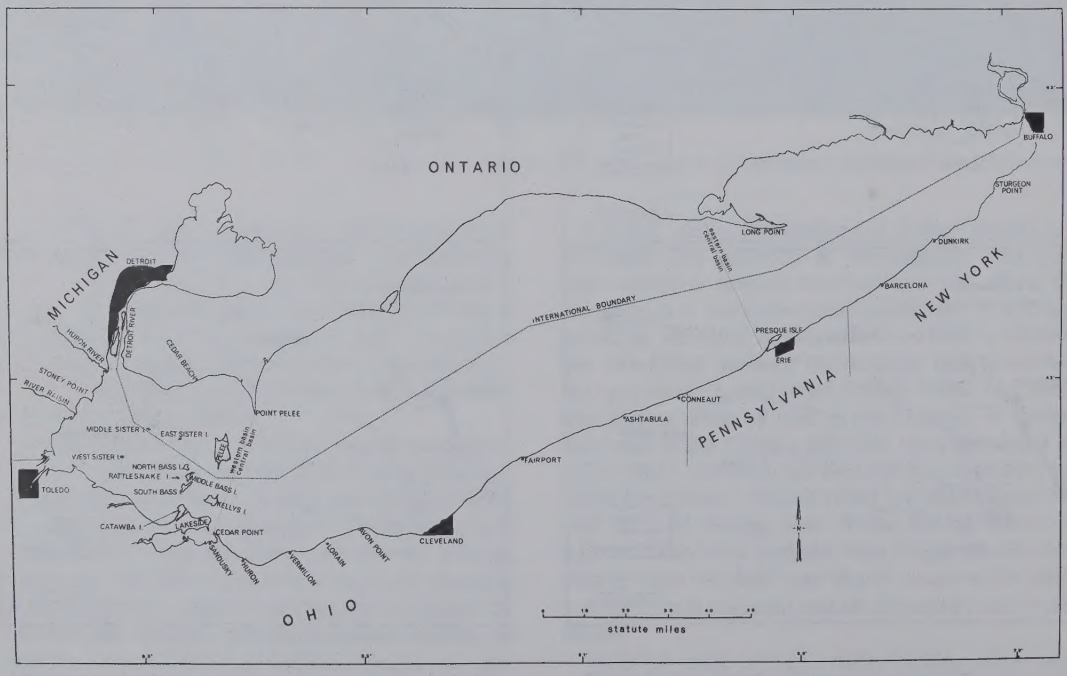

Figure 4.—Map of Lake Erie showing basins and geographic locations mentioned throughout text.

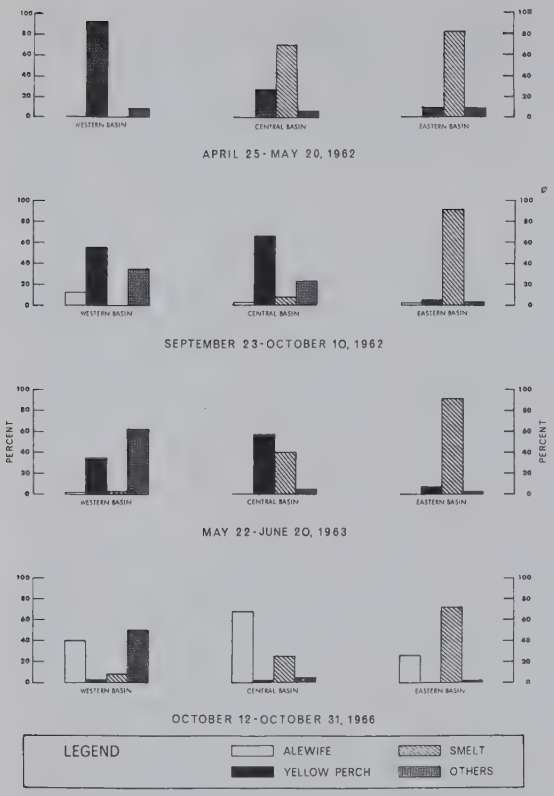

Figure 5.—Percentage species composition of alewife, smelt, and yellow perch in exploratory trawl catches by basin and year in Lake Erie.

In all, the 245 exploratory trawl catches yielded 31 species of fish (positively identified). One other species, the silver chub, *Hybopsis storeriana,* was tentatively identified but not verified, and is therefore not included in the species composition count. Van Meter and Trautman (1970) reported that 138 species have been reported in Lake Erie at one time or another. Nine species—yellow perch; rainbow smelt; alewife; freshwater drum; carp; gizzard shad, *Dorosoma cepedianum;* channel catfish; white bass; and goldfish, *Carassius auratus* —composed 98.4% of the total catch. The remaining 22 miscellaneous species were not taken in significant quantities. The occurrence, total pounds landed, catch rate, and average catch for effective effort for all species are summarized in Table 1.

Figure 6.—Species composition of exploratory trawl catches by year in Lake Erie.

DISCUSSION BY BASIN

The following section discusses the physical characteristics, catch rates, best catches, and high yield locations of the three basins of Lake Erie.

Western Basin

Collectively, for all four cruises in the Western Basin, the 16,995 pounds of fish landed, yielded an average ½-hr catch of 287 pounds. The 1,265 square miles of surface area in the basin represent 12.8% of the total surface area of Lake Erie. The 60 exploratory drags completed in the Western Basin disclosed many new grounds suitable for bottom trawling. For the most part, the Western Basin has a mud bottom. It has, however, a rather extensive area of sand which extends from south of the Detroit River east to Pelee Island. Also, a narrow band of clay interspersed with rock and gravel shoals follows the Ohio shore. This bottom area has traditionally been the spawning grounds of many fishes.

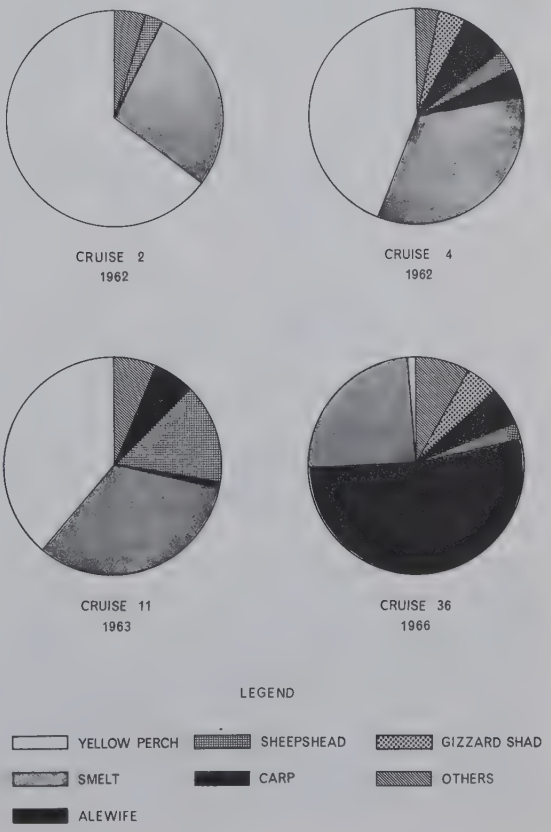

Table 1.—Species composition of 245 trawl catches by RV *Kaho* in Lake Erie, 1962-66.

Species	Total catch		Occurrences in total drags		Catch rate per 1/2 hr effort	Average catch for effective 1/2 hr effort
	Pounds	Percent 1/	Number	Percent 1/	Pounds 1/	Pounds
Yellow perch (Perca flavescens)	15,455	32.1	203	82.9	65.3	79.3
Rainbow smelt (Osmerus mordax)	14,760	30.7	219	89.4	62.4	69.6
Alewife (Alosa pseudoharengus)	7,200	15.0	104	42.4	30.4	71.6
Freshwater drum (Aplodinotus grunniens)	3,709	7.7	97	39.6	15.7	39.2
Carp (Cyprinus carpio)	2,939	6.1	47	19.2	12.4	64.9
Gizzard shad (Dorosoma cepedianum)	1,216	2.5	55	22.4	5.1	23.2
Channel catfish (Ictalurus punctatus)	944	2.0	45	18.4	4.0	21.8
White bass (Roccus chrysops)	654	1.4	114	46.5	2.8	6.0
Goldfish (Carassius auratus)	447	0.9	8	3.3	1.9	55.9
Walleye (Stizostedion vitreum vitreum)	229	0.5	50	20.4	1.0	4.6
Spottail shiner (Notropis hudsonius)	138	0.3	80	32.7	0.6	1.8
Emerald shiner (Notropis atherinoides)	100	0.2	31	12.7	0.4	32.3
White sucker (Catostomus commersoni)	78	0.2	34	13.9	0.3	2.3
Burbot (Lota lota)	58	0.1	12	4.9	0.2	4.8
Trout-perch (Percopsis omiscomaycus)	53	0.1	43	17.6	0.2	1.2
Quillback (Carpiodes cyprinus)	30	T	7	2.9	0.1	4.3
Sauger (Stizostedion canadense)	23	T	2	0.8	0.1	11.5
Lake whitefish (Coregonus clupeaformis)	22	T	5	2.0	0.1	4.4
Black bullhead (Ictalurus melas)	19	T	11	4.5	0.1	1.8
Lake herring (Coregonus artedii)	15	T	2	0.8	0.1	7.5
Stonecat (Noturus flavus)	4	T	4	1.6	T	1.1
Stoneroller (Compostoma anomalum)	4	T	4	1.6	T	1.0
Sea lamprey (Petromyzon marinus)	3	T	3	1.2	T	1.0
White crappie (Pomoxis annularis)	2	T	2	0.8	T	1.5
Buffalo (Ictiobus sp.)	2	T	1	0.8	T	1.1
Yellow bullhead (Ictalurus natalis)	2	T	2	0.8	T	1.0
Smallmouth bass (Micropterus dolomieui)	1	T	1	T	T	1.0
Pumpkinseed (Lepomis gibbosus)	1	T	1	T	T	1.0
Rock bass (Ambloplites rupestris)	1	T	1	T	T	2.0
Longnose gar (Lepisosteus osseus)	1	T	1	T	T	1.0
Logperch (Percina caprodes)	1	T	1	T	T	1.3
TOTALS	48,111	99.8			203.2	

1/ T = Trace, less than 0.1.

All trawling in this basin was conducted in waters from 3 to 7 fathoms with 76.7% of all drags being made at depths of 4 and 5 fathoms. Though the Western Basin has a maximum depth of 8 fathoms, it has a mean depth of about 4 fathoms. The many islands in the eastern portion of the basin are surrounded by shallow water.

Cruise 2, April-May 1962.—Catches during Cruise 2 were not large enough to be considered commercially significant with the exception of three good catches of yellow perch. The catch rate for all fish caught during Cruise 2 was 96.3 pounds per one-half hour of effort. The general lack of fish concentrations throughout trawlable areas probably can be accounted for by the normal seasonal inshore spawning run which was underway at the time.

On the basis of the standard ½-hr drag, best catches of yellow perch were as follows: 190 pounds at 3 fathoms, east of Stony Point, Mich.; 200 pounds at 5 fathoms, west of Pelee Island; and 240 pounds at 7 fathoms, north of Kelleys Island. Nearly all perch caught were 7.5 to 8.5 inches; the average length was 8.0 inches.

Cruise 4, September-October 1962.—As a result of eight exploratory drags during Cruise 4, a ½-hr catch rate of 439.5 pounds was obtained with total production reaching 3,516 pounds of fish.

Yellow perch made up 51.6% of the total catch, of which 31.9% were 8 inches or more, 19.2% were between 4 and 8 inches, and 0.5% were under 4 inches long. The remainder of the total catch, in order of decreasing abundance, was carp, alewife, freshwater drum, and gizzard shad.

All drags were west of the tip of Catawba Island, Ohio, and Cedar Beach, Ontario, at depths between 4 and 5 fathoms. Five of the eight drags were in areas with mud bottoms and three drags were in areas containing a mixture of mud and sand. Best catches were southeast of the mouth of the River Raisin, northeast of West Sister Island, southeast of East Sister Island, and west of Rattlesnake Island. One 200-pound catch of alewives was made just west of Put-in-Bay, South Bass Island, in 5 fathoms.

Cruise 11, May-June 1963.—During Cruise 11, 27 drags yielded a total production of 8,192 pounds of fish at an average ½-hr catch rate of 312.7 pounds.

Trawl catches of yellow perch were equal to, or better than, catches made by Bureau research vessels since exploratory fishing was first started in Lake Erie in 1958. Of the 2,795 pounds of yellow perch taken during this cruise, 34.2% was taken at depths ranging between 3 and 4 fathoms, and 65.8% was taken between 4 and 7 fathoms; corresponding ½-hr catch rates were 115.1 pounds and 103.4 pounds, respectively.

An exceptionally good catch of 950 pounds of freshwater drum was taken west of Put-in-Bay in 5 fathoms. Another 30-min drag in 3 fathoms west of the tip of Catawba Island produced 550 pounds of drum. Smelt landings on this cruise accounted for 2% of all fish taken in the Western Basin; the largest catch—80 pounds—was taken in 5 fathoms directly south of Middle Sister Island.

Best individual catches of yellow perch were 320 pounds taken 1 mile west of South Bass Island in 4 fathoms and 500 pounds taken 3 miles southeast of Middle Sister Island in 5 fathoms of water.

Mud was the most common bottom type throughout this cruise, although several stations directly south of the mouth of the Detroit River showed a mixture of sand and mud. Trawling bottom was good except for a location approximately 4 miles east of South Bass Island, which had a rough bottom.

Cruise 36, October 1966.—Of the 13 drags completed in the Western Basin during Cruise 36, 10 were made near South, Middle, and North Bass Islands, in depths of 3 to 7 fathoms. The total of 4,131 pounds of fish landed corresponded to an average ½-hr catch rate of 317.8 pounds.

During this cruise the 1,648 pounds of alewives landed accounted for 39.9% of the total catch; 74.3% of these alewives, however, were from two 30-min drags. One catch of 475 pounds was taken at 5 fathoms southeast of Middle Sister Island, and the largest catch of 750 pounds was made at 4 fathoms, alongside the Toledo channel in the extreme western end of the lake.

Previous cruises had produced few alewives; instead, the dominant species had been yellow perch, freshwater drum, and carp. Carp landings, this cruise, totaled 569 pounds; the two best catches were 150 and 170 pounds. Carp were taken from 12 of the 13 trawl stations in amounts ranging from 3 to 170 pounds per drag.

A total of 426 pounds of gizzard shad was taken—the largest catch (120 pounds) from 4

Figure 7.—Typical mixed catch of Lake Erie fish from the western basin; catch was dominated by carp, sheepshead, yellow perch, and alewife.

fathoms off Lakeside, Ohio. Smelt were taken in all trawl drags in amounts of 1 to 75 pounds. During previous cruises, smelt accounted for only a very small portion of the total Western Basin landings; during this cruise, however, smelt made up 8.2% of the catch, a rise of 6% over Cruise 11 (Fig. 7).

Central Basin

Collectively, for all four cruises in the Central Basin the 21,351 pounds of fish landed yielded an average ½-hr catch rate of 179.3 pounds.

The Central Basin has a surface area of 6,246 square miles and accounts for 62.9% of the total area of Lake Erie. The U.S. waters of this basin provide numerous areas suitable for bottom trawling. The shallow waters, however, are generally not suited to trawling because of rough bottom or the presence of stationary gill nets or trap nets.

Cruise 2 produced 589 pounds of fish with an average ½-hr catch rate of 19 pounds. Best ½-hr catches of smelt were 65 pounds taken off Fairport, Ohio, at a depth of 13 fathoms, and 75 pounds at 7 fathoms off Lorain, Ohio. Only one notable catch of yellow perch (110 pounds) was made just east of Kelleys Island in the extreme western end of the Central Basin.

Cruise 4 produced 6,647 pounds of fish at an average ½-hr catch rate of 247 pounds. The average ½-hr catch rate of yellow perch was 169 pounds; concentrations of young-of-the-year were heavy in 11, 12, and 13 fathoms from Erie, Pa., to Vermilion, Ohio. Smelt, gizzard shad, and freshwater drum —the second, third, and fourth most abundant

species in the catch—accounted for 7.9, 6.9, and 4.6% of the total.

The largest catch of smelt was 250 pounds, at 7 fathoms off Vermilion. Of the 4,560 pounds of yellow perch taken, 7.6% were from waters 5 to 10 fathoms deep and 92.4% were from 11 to 13 fathoms.

Cruise 11 produced 7,613 pounds of fish at an average ½-hr catch rate of 215 pounds. Catches of yellow perch were good off Avon Point and Fairport, Ohio; two drags yielded 540 and 410 pounds, respectively. Both catches were from 9 fathoms. Two catches of 390 and 300 pounds were taken east of Kelleys Island in 7 fathoms, and 220 pounds were taken north of Ashtabula, Ohio, from 11 fathoms. Eleven drags in the Central Basin produced from 100 to 470 pounds of smelt; catches were good near Ashtabula, Conneaut, Fairport, and between Huron and Vermilion, at depths of 7 to 11 fathoms. No species other than yellow perch and rainbow smelt were taken in quantities large enough to be considered commercially significant.

Cruise 36 produced 6,502 pounds of fish with an average ½-hr catch rate of 253 pounds. Alewife were present in all 28 drags and accounted for 4,454 pounds, or 68.5%, of the total catch. The average ½-hr catch rate was slightly more than 173 pounds per drag, and catches of 200 pounds and more were made in 14 of the 28 drags. The largest catch (350 pounds) was made off Huron, Ohio, in 7 fathoms. Catches were generally greatest at 10 fathoms and deeper, where the catch rate for alewife was 215 pounds per ½-hr drag.

Smelt, the second most abundant species, accounted for 1,652 pounds of the total catch. The largest catch of 225 pounds was taken at 9 fathoms off Ashtabula. Most smelt catches were considerably smaller than those of preceding cruises, a fact reflected by the average ½-hr catch rate of only 64.3 pounds.

The few gizzard shad caught (144 pounds) were mostly taken west of Cleveland, Ohio. During this cruise, trawling in the Central Basin produced only 93 pounds of yellow perch; the largest catch of 30 pounds was taken from 12 fathoms off Ashtabula. Though yellow perch appeared in 19 of the 28 catches, 18 of the 19 produced only 1 to 10 pounds.

Eastern Basin

The Eastern Basin occupies 2,408 square miles of surface area—24.3% of the total surface area of the lake. The Eastern Basin has a predominantly mud bottom, though sand or clay often may extend out from shore and into bays. Bottom conditions throughout the U.S. portion of the Eastern Basin were trawlable, with the exception of most water shallower than 7 fathoms.

Cruise 2, April-May 1962.—During Cruise 2, the 13 drags made in the Eastern Basin produced a total of only 140 pounds of fish at an average ½-hr catch rate of 10.8 pounds. Though few fish were located in trawlable areas, one heavy midwater concentration several miles long was recorded on the echo sounder in the deepest area of the lake near the junction of the international and New York-Pennsylvania boundaries. The largest single catch was 55 pounds of smelt from 6 fathoms taken off Sturgeon Point, N.Y. Other catches ranged from 1 to 15 pounds.

Cruise 4, September-October 1962.—Cruise 4 produced commercially significant catches of smelt taken from waters between 12 and 25 fathoms deep. Five drags off Barcelona, N.Y., took 150, 300, 450, 480, and 600 pounds each; and off Erie, Pa., three drags took 120, 150, and 1,120 pounds each. All drags lasted the standard 30 min. A total of 4,650 pounds of smelt in 18 drags gave a ½-hr catch rate of 258 pounds.

Yellow perch was caught in 16 of the 18 drags; the largest catch of 170 pounds was taken in 14 fathoms off Erie. The remaining catches of yellow perch ranged between 1 and 11 pounds. The average ½-hr catch rate was only 15 pounds. Alewife appeared in 12 of the drags but never exceeded 8 pounds per drag.

Cruise 11, May-June 1963.—During Cruise 11, smelt continued to be the dominant species; 3,097 pounds were taken in 23 drags. The average ½-hr catch rate for all species combined was 156.5 pounds. Alewife were not taken from this basin during the cruise.

The best catch of smelt was 550 pounds in 15 fathoms off Erie, Pa. On the New York-Pennsylvania border, 250 pounds were taken from 18 fathoms. In the Dunkirk-Sturgeon Point area, catches were 250, 350, and 380 pounds at depths of 9 and 10 fathoms. For all drags the average ½-hr catch rate for smelt was 142.7 pounds.

Only 247 pounds of yellow perch were taken in 20 drags; the largest catch of 75 pounds was taken in 14

Figure 8.—Typical catch of fish from the central basin of Lake Erie, consisting of nearly equal amounts of yellow perch, smelt, and alewife.

fathoms off Erie. Other catches of yellow perch ranged from 1 to 50 pounds.

Cruise 36, October 1966.—During Cruise 36, severe weather limited trawling in the Eastern Basin to six drags. Smelt accounted for 820 pounds of the total catch of 1,126 pounds. The largest smelt catch was 325 pounds taken at 20 fathoms northeast of Erie, Pa. Other smelt catches ranged from 10 to 200 pounds and averaged 103.1 pounds per ½-hr drag.

A total of 290 pounds of alewife were caught in six drags. The largest catch of 160 pounds was taken from 15 fathoms northeast of Erie. Other catches ranged from 10 to 75 pounds.

Figure 9.—Typical catch of fish from the eastern basin of Lake Erie. Catch was composed of about 75% smelt and 25% alewife.

DISCUSSION BY SPECIES

The following section discusses fishing results for each of the more important species taken during this study. The order of discussion is based on the order of the total landings for the four cruises.

Yellow Perch

Though yellow perch was the most abundant of the 31 species recorded in trawl catches during these explorations, the number of pounds caught and the percentage of catch composition dropped off drastically between 1963 and 1966. The best ½-hr catch of yellow perch was made during Cruise 4, when 1,040 pounds were taken at a depth of 12 fathoms in the Central Basin off Fairport, Ohio.

Clearly, yellow perch were concentrated in the Western and Central Basins; the Eastern Basin produced only modest catches. Yellow perch was taken mainly at depths of 3 to 7 fathoms in the Western Basin, from 3 to 13 fathoms in the Central Basin, and from 6 to 32 fathoms in the Eastern Basin. The best catches were in the Western Basin from 5 fathoms. Thirteen of the 33 drags made at that depth produced catches ranging from 100 to 720 pounds per drag. Of the 13 drags that produced 100 or more pounds of yellow perch, 7 produced catches from 100 to 199 pounds, 3 from 200 to 499 pounds, and 3 from 500 to 720 pounds.

Rainbow Smelt

Throughout the study period, smelt was the most

stable of the three most abundant species (yellow perch, smelt, and alewife), although the percentage of smelt in the catches showed a slight decline from 1962 to 1966.

The largest quantities of smelt were taken from the Eastern Basin where it remained the dominant species throughout the study. The majority of drags that produced catches in excess of 100 pounds were at depths of 9 to 30 fathoms. The largest catch of smelt (1,120 pounds) was taken at 19 fathoms northeast of Erie, Pa., during Cruise 4.

From the Western Basin, only 5% of the drags produced catches of 50 to 80 pounds taken from 4 and 5 fathoms; in the Central Basin, catches ranged from 1 to 470 pounds and varied from 3 to 13 fathoms.

Alewife

During the study period the number of pounds taken by the trawl of alewife progressively increased to the point where this species dominated the total catch landed in 1966. In terms of pounds, the alewife landings in 1966 (6,392 pounds) were nearly 10 times greater than those made during Cruise 4 (September-October 1962) and 41 times greater than those made during Cruise 11 (May-June 1963). Alewife landings during Cruise 4 were taken mainly from the Western and Central Basins, but landings during Cruise 11 came almost exclusively from the Western Basin. Catches landed during Cruise 36 (October 1966) were primarily from the Western and Central Basins, although the size of catches taken from the Eastern Basin increased somewhat.

Throughout the period, alewife was taken from the Western Basin at depths of 3 to 7 fathoms; the best concentrations were at 4 to 5 fathoms. Central Basin catches ranged from 3 to 13 fathoms, but best concentrations were at 10 to 13 fathoms. Eastern Basin catches were scattered between 10 and 30 fathoms; the largest landing was taken from 15 fathoms.

The largest catch of alewife (750 pounds) was taken from the Western Basin in 4 fathoms, northeast of the Maumee River during Cruise 36.

Freshwater Drum

Freshwater drum was the fourth most abundant species in trawl catches through the study. A total of 3,709 pounds were taken; best catches were from the Western Basin at 3 to 7 fathoms. Central Basin catches were more sporadic: catches ranged from 1 to 70 pounds and were taken from water between 3 and 13 fathoms deep. Only a few (4 pounds) drum were taken from the Eastern Basin through the entire period.

The largest catch of drum (950 pounds) was taken from the Western Basin at 5 fathoms south of Rattlesnake Island on 23 May 1963.

Carp

Carp, the fifth most abundant species in trawl catches yielded landings of 2,939 pounds during the study, slightly more than 86% of the carp came from the Western Basin. All carp were caught in waters from 3 to 10 fathoms deep, though better than 80% of the carp came from 4 to 6 fathoms. Seven drags in the Western Basin produced catches of 150 to 510 pounds. These catches were made east and west of the North, Middle, and South Bass Islands. The best catch (510 pounds) was taken from 4 fathoms east of South Bass Island. More than 82% of the 359 pounds of carp from the Central Basin were taken from 7 and 8 fathoms. The largest catch (120 pounds) was made at 7 fathoms from the extreme western end of the Central Basin. The Eastern Basin produced a total of only 46 pounds all from two drags during Cruise 4.

Gizzard Shad

The sixth most abundant species, gizzard shad, made up 2.5% of the total catch; 1,216 pounds were taken in 55 drags. The largest number of gizzard shad appeared in 1962 (643 pounds); during the 1963 exploration, however, catches fell off dramatically to where only 1 pound was taken. In 1966 catches increased to the point where 55 pounds were taken from 30 drags. Though gizzard shad was taken at depths up to 15 fathoms, most were taken at 4 to 8 fathoms. Three catches exceeded 100 pounds, two catches from the Western Basin during Cruise 36 (October 1966) and the third from the Central Basin during Cruise 4.

Miscellaneous Species

The following species, in order of descending poundage, were taken in trawl catches from Lake Erie: channel catfish; white bass; goldfish; walleye; spottail shiner, *Notropis hudsonius;* emerald shiner, *Notropis atherinoides;* white suckers,

Catostomus commersoni; burbot, *Lota lota;* trout-perch, *Percopsis omiscomaycus;* quillback, *Carpoides cyprinus;* sauger; lake whitefish; black bullhead, *Ictalurus melas;* lake herring; stonecat, *Noturus flavus;* stoneroller, *Campostoma anomalum;* sea lamprey, *Petromyzon marinus;* white crappie, *Pomoxis annularis;* buffalo, *Ictiobus* sp.; yellow bullhead, *Ictalurus natalis;* smallmouth bass, *Micropterus dolomieui;* pumpkinseed, *Lepomis gibbosus;* rock bass, *Ambloplites repestris;* longnose gar, *Lepisosteus osseus;* and logperch, *Percina caprodes.*

Only channel catfish and white bass were caught in quantities with regularity. Though total poundage of the above 25 miscellaneous species amounted to 5.9% of the total landings, the first six species accounted for 5.2%; the remaining 19 species contributed only 0.7% of the total.

SUMMARY AND CONCLUSIONS

The Bureau of Commercial Fisheries, Exploratory Fishing and Gear Base at Ann Arbor, conducted a 4-Cruise exploratory fishing survey throughout the U.S. waters of Lake Erie between April 1962 and October 1966 aboard the RV *Kaho.* The objectives of this survey were to determine the feasibility of using the bottom trawl in various areas of Lake Erie and to determine the relative abundance, location, and depth distribution of various fish stocks within the lake. The following conclusions may be drawn from the results of these efforts:

1. With few exceptions, the bottom of all U.S. waters of the three basins of Lake Erie was suitable for bottom trawling.
2. Yellow perch and rainbow smelt were harvested with bottom trawl in amounts considered to be commercially significant. Alewife, freshwater drum, carp, gizzard shad, channel catfish, and white bass provided significant supplements to total catches and collectively contributed 34.6% to the total landings.
3. Yellow perch was taken from the Western and Central Basins in good quantities in 1962 and 1963, but during the 1966 survey, yellow perch was not taken from any basin by trawl in quantities large enough to be considered commercially significant.
4. Alewife was not taken at all during Cruise 2 (April-May 1962) and catches were small during Cruises 4 (September-October 1962) and 11 (May-June 1963). During Cruise 36 (October 1966), good catches—made in each of the three basins—accounted for the largest portion of the total catch.
5. Rainbow smelt declined slightly between 1962 and 1966, but the species remained the second most abundant (by weight) during each cruise. Best concentrations of smelt were in the Eastern Basin of the lake.
6. Walleye, sauger, lake whitefish, and lake herring, all once commercially abundant in Lake Erie, were not located in commercially significant amounts during this study.

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Appendix Table 1.—RV *Kaho* fishing log—trawl stations in the Western Basin of Lake Erie.

Cruise No.	Depth	Date	Drag No.	Position Lat. N.	Position Long. W.	Time Course of day	Fished	Limiting factor 1/	Catch Yellow perch	Rainbow Smelt	Alewife	Freshwater drum	Carp	Gizzard shad	Channel catfish	White bass	Others 2/	Total
	Fath.	1962					Min.		Pounds									
2	3	5-20	61	41°56'	83°12'	SW. 1400	30	0	190	1	-	-	-	-	-	7	2	200
	3	5-20	62	41°48'	83°16'	SW. 1530	30	5	95	-	-	-	-	-	-	-	5	100
	4	5-14	53	41°35'	82°55'	E. 1630	30	0	20	1	-	5	-	-	-	-	1	27
	4	5-15	54	41°42'	83°14'	SE. 1510	30	0	7	1	-	3	-	-	-	15	3	29
	4	5-20	60	41°54'	83°09'	NE. 1300	30	0	90	1	-	5	-	-	-	-	4	100
	5	5-14	51	41°42'	82°43'	SW. 1500	30	0	28	1	-	2	1	-	-	-	-	32
	5	5-14	52	41°38'	82°46'	S. 1610	30	0	18	1	-	3	-	-	-	4	1	27
	5	5-16	55	41°40'	82°52'	NW. 0810	30	0	15	1	-	-	-	-	1	2	2	21
	5	5-16	56	41°45'	82°51'	NW. 0920	30	0	70	2	-	1	-	-	-	-	2	75
	5	5-16	57	41°47'	82°46'	SW. 1050	30	0	200	1	-	8	-	-	-	-	1	210
	5	5-20	59	41°49'	83°00'	E. 1120	30	0	80	1	-	-	-	-	-	1	3	85
	7	5-16	58	41°38'	82°41'	W. 1300	30	0	240	1	-	-	-	-	3	-	6	250
		1962																
4	4	9-23	63	41°56'	83°08'	S. 1000	30	0	1	-	1	-	-	-	-	1	3	6
	4	9-24	69	41°36'	82°52'	S. 1140	30	0	25	-	90	50	22	80	10	-	33	310
	5	9-23	64	41°52'	83°17'	S. 1110	30	0	720	-	30	11	15	-	-	-	4	780
	5	9-23	65	41°47'	83°00'	E. 1310	30	0	550	-	20	20	80	1	10	1	8	690
	5	9-23	66	41°46'	82°54'	SE. 1410	30	0	220	-	35	75	220	1	20	-	9	580
	5	9-24	67	41°42'	82°58'	SE. 0910	30	0	230	1	-	10	80	30	10	5	14	380
	5	9-24	68	41°40'	82°51'	S. 1020	30	0	45	1	200	5	150	60	10	3	6	480
	5	9-24	70	41°41'	82°42'	SW. 1340	30	0	25	-	-	8	220	5	20	3	9	290
		1963																
11	3	5-23	131	41°35'	82°53'	W. 1330	30	0	150	-	-	550	-	-	100	-	10	810
	3	5-23	132	41°34'	82°56'	W. 1450	10	3	40	-	-	140	2	-	45	1	2	230
	3	5-26	144	41°41'	83°14'	NW. 1010	30	0	70	1	50	12	2	-	-	7	28	170
	4	5-23	129	41°39'	82°48'	SW. 1000	30	0	320	5	1	150	510	-	23	4	28	1,041
	4	5-25	141	41°55'	83°07'	SW. 1310	30	0	50	25	20	5	-	-	-	2	38	140
	4	5-25	142	41°52'	83°11'	S. 1410	30	0	70	5	5	4	-	-	-	9	7	100
	4	5-26	143	41°47'	83°12'	S. 0840	30	0	65	5	10	20	-	-	5	5	10	120
	4	5-26	145	41°44'	83°06'	S. 1130	30	0	100	5	50	7	15	-	2	35	16	230
	4	5-28	154	41°39'	82°45'	SW. 1240	30	0	90	1	1	70	13	-	80	20	5	280
	5	5-23	128	41°38'	82°44'	S. 0830	25	8	190	1	-	40	10	-	5	-	14	260
	5	5-23	130	41°40'	82°50'	NW. 1150	30	0	25	-	-	950	440	-	200	1	14	1,630
	5	5-25	138	41°40'	82°56'	NW. 0900	30	0	170	-	1	10	-	-	11	4	14	210
	5	5-25	139	41°45'	82°52'	SE. 1020	30	0	190	1	5	22	-	-	-	11	11	240
	5	5-25	140	41°48'	82°59'	NW. 1130	30	0	500	5	5	19	-	-	-	2	10	541
	5	5-26	146	41°48'	83°06'	SE. 1240	30	0	100	1	1	20	-	-	-	25	3	150
	5	5-28	153	41°39'	82°48'	N. 1140	30	0	180	1	-	70	5	-	19	2	3	280
	5	6-15	198	41°40'	82°56'	NW. 0720	30	0	120	-	-	12	-	-	2	3	3	140
	5	6-15	199	41°44'	83°02'	NW. 0830	30	0	75	1	1	5	12	-	1	3	2	100
	5	6-15	200	41°48'	83°00'	SE. 0940	30	0	2	80	1	-	-	-	-	4	3	90
	5	6-15	201	41°46'	82°54'	SE. 1040	30	0	140	-	1	21	-	-	5	10	3	180
	5	6-15	202	41°40'	82°50'	W. 1200	30	0	10	1	1	140	90	-	33	7	18	300
	5	6-15	203	41°40'	82°52'	SW. 1250	30	0	5	-	-	40	20	-	13	13	19	110
	5	6-15	204	41°39'	82°52'	W. 1330	30	0	15	-	-	15	5	-	14	20	31	100
	5	6-15	205	41°40'	82°51'	SE. 1420	30	0	13	-	-	200	40	-	45	15	7	320
	6	5-26	147	41°43'	82°46'	SE. 1510	30	0	85	5	-	32	-	-	5	3	10	140
	6	6-16	206	41°42'	82°45'	S. 0710	30	0	10	3	-	30	1	-	2	9	25	80
	7	6-16	207	41°39'	82°42'	E. 0800	30	0	10	20	-	150	12	-	-	1	7	200
		1966																
36	3	10-13	240	41°55'	83°18'	E. 0930	30	0	50	25	1	2	43	5	1	-	404	533
	3	10-18	247	41°33'	83°01'	E. 1030	30	0	-	20	75	-	3	75	-	1	2	176
	4	10-12	238	41°47'	83°19'	NE. 1440	30	0	8	50	750	5	6	30	-	5	2	856
	4	10-18	246	41°34'	82°50'	SE. 0820	30	0	1	30	35	8	70	120	-	10	14	288
	5	10-12	239	41°49'	83°09'	SE. 1610	30	0	3	30	40	5	-	3	-	1	12	94
	5	10-13	241	41°43'	83°05'	E. 1400	30	0	7	30	70	21	30	100	15	10	8	291
	5	10-13	242	41°37'	82°52'	N. 1540	30	0	1	10	5	10	8	-	2	10	4	50
	5	10-14	244	41°51'	83°01'	S. 0930	30	0	1	25	475	1	4	1	-	-	2	509
	5	10-18	248	41°37'	82°44'	N. 1210	30	0	2	75	75	6	6	75	-	3	1	243
	6	10-14	243	41°35'	83°25'	N. 0750	30	0	-	1	16	21	70	1	17	15	11	152
	5	10-18	250	41°42'	82°50'	W. 1440	30	0	1	2	1	100	170	1	55	6	16	352
	6	10-14	245	41°47'	83°01'	SE. 1030	30	0	1	20	75	2	7	5	-	2	4	116
	7	10-18	249	41°42'	82°45'	NW. 1310	30	0	20	20	30	90	150	10	115	10	26	471

1/ 0 - clear drag, 1 - snag encountered (no gear damage), 2 - gear malfunction, 3 - minor gear damage, 4 - major gear damage (including loss of net), 5 - wind over 20 m.p.h., 6 - strong current, 7 - adverse weather condition (including high seas, fog, and ice), 8 - rough bottom, 9 - set fishing gear in area.

2/ Include goldfish, walleye, spottail shiner, emerald shiner, white sucker, burbot, trout-perch, quillback, sauger, Lake whitefish, black bullhead, lake herring, stonecat, stoneroller, sea lamprey, white crappie, buffalo, yellow bullhead, logperch, longnose gar, smallmouth bass, pumpkinseed, and rock bass.

Appendix Table 2.—RV *Kaho* fishing log—trawl stations in the Central Basin of Lake Erie.

Cruise No.	Depth	Date	Drag No.	Position Lat. N.	Position Long. W.	Course	Time of day	Fished	Limiting factor 1/	Catch: Yellow perch	Rainbow Smelt	Alewife	Freshwater drum	Carp	Gizzard shad	Channel catfish	White bass	Others 2/	Total
	Fath.	1962						Min.		Pounds									
2	3	5-14	47	41 30'	82 39'	NE.	0930	30	0	20	5	-	10	-	-	1	1	1	38
	6	5-13	42	40 27'	82 19'	NE.	0810	30	0	3	10	-	4	-	-	-	1	-	18
	7	5-9	24	42 05'	80 29'	SW.	1710	30	0	1	1	-	7	-	-	-	-	2	11
	7	5-11	31	41 51'	81 07'	E.	0920	30	0	-	2	-	1	-	-	-	-	-	3
	7	5-12	41	41 40'	81 30'	SW.	1410	30	0	-	12	-	-	-	-	-	-	-	12
	7	5-13	43	41 32'	82 16'	W.	0930	30	0	1	1	-	-	-	-	-	1	-	3
	7	5-13	44	41 36'	82 16'	W.	1040	30	0	5	75	-	-	-	-	-	-	-	80
	7	5-14	48	41 36'	82 34'	W.	1100	30	0	1	5	-	-	-	-	-	-	-	6
	7	5-14	49	41 40'	82 34'	SE.	1210	30	0	1	3	-	-	-	-	-	2	-	6
	7	5-14	50	41 36'	82 37'	SW.	1250	30	0	110	50	-	-	-	-	-	-	-	160
	8	5-10	25	41 58'	80 39'	E.	0710	30	0	-	-	-	-	-	-	-	-	-	-
	8	5-11	37	41 47'	81 20'	W.	1700	30	0	-	1	-	-	-	-	-	-	-	1
	9	5-9	23	42 07'	80 24'	SW.	1510	30	0	-	1	-	-	-	-	-	-	-	1
	9	5-10	30	42 00'	80 41'	W.	1800	30	0	3	1	-	-	-	-	-	1	1	6
	10	5-11	32	41 53'	81 06'	W.	1030	30	0	-	1	-	-	-	-	-	-	-	1
	10	5-11	36	41 48'	81 18'	W.	1610	30	0	-	1	-	-	-	-	-	-	-	1
	10	5-12	40	41 44'	81 31'	W.	1250	30	0	-	5	-	-	-	-	-	-	-	5
	10	5-13	45	41 39'	82 16'	SE.	1200	30	0	1	25	-	-	-	-	-	-	-	26
	11	5-9	20	42 15'	80 32'	N.	0950	30	5	-	-	-	-	-	-	-	-	-	-
	11	5-10	26	42 03'	80 39'	W.	0850	30	0	1	1	-	-	-	-	-	-	-	2
	11	5-10	27	42 17'	80 43'	SW.	1310	30	0	1	2	-	-	-	-	-	-	-	3
	11	5-13	46	41 43'	82 12'	NW.	1340	30	0	1	20	-	-	-	-	-	-	-	21
	12	5-9	21	42 14'	80 28'	SW.	1150	30	0	-	1	-	-	-	-	-	-	-	1
	12	5-9	22	42 09'	80 24'	SW.	1350	30	0	1	1	-	-	-	-	-	-	-	2
	12	5-10	28	42 13'	80 46'	SW.	1430	30	0	1	3	-	-	-	-	-	-	-	4
	12	5-10	29	42 08'	80 41'	SW.	1600	30	0	-	1	-	-	-	-	-	-	2	3
	12	5-11	33	41 52'	81 08'	E.	1140	30	0	-	8	-	-	-	-	-	-	-	8
	12	5-11	35	41 53'	81 19'	E.	1240	30	0	-	40	-	-	-	-	-	-	-	40
	12	5-12	39	41 44'	81 33'	E.	1050	30	0	-	17	-	-	-	-	-	-	-	17
	13	5-11	34	41 52'	81 17'	W.	1320	30	0	-	65	-	-	-	-	-	-	-	65
	13	5-12	38	42 01'	81 31'	W.	0910	30	0	-	45	-	-	-	-	-	-	-	45
		1962																	
4	5	9-25	71	41 27'	82 36'	N.	0940	4	3	1	1	-	-	1	4	1	1	1	10
	6	10-4	98	42 00'	80 32'	E.	1550	30	0	12	6	-	-	-	-	-	90	2	110
	6	10-10	122	41 35'	82 20'	NE.	1200	30	0	10	25	1	-	-	10	-	-	1	47
	6	10-10	123	41 39'	82 22'	N.	1400	30	0	-	1	1	-	-	1	-	1	-	4
	6	10-10	124	41 40'	82 22'	W.	1450	30	0	2	10	1	1	45	6	-	-	-	65
	7	9-25	72	41 33'	82 36'	NE.	1030	30	0	-	-	-	1	-	1	-	-	-	2
	7	9-25	73	41 35'	82 35'	SW.	1120	30	0	1	-	1	4	120	5	4	3	2	140
	7	9-26	74	41 36'	82 34'	E.	1450	30	0	2	1	1	1	-	40	1	2	2	50
	7	10-10	121	41 33'	82 23'	E.	1100	30	0	120	250	1	4	-	40	3	6	6	430
	8	9-26	75	41 34'	82 28'	NE.	1610	30	0	25	1	1	40	20	130	2	3	8	230
	8	9-26	76	41 38'	82 27'	W.	1730	30	0	20	1	1	5	95	80	-	3	5	210
	8	10-4	95	42 19'	80 21'	W.	1140	30	0	10	10	5	-	-	5	-	2	1	33
	9	10-7	115	41 38'	81 37'	W.	1400	30	0	65	2	12	12	-	16	-	8	5	120
	9	10-8	116	41 34'	81 48'	W.	0820	30	0	20	1	35	11	-	50	-	30	3	150
	10	10-6	104	41 50'	81 15'	NE.	0820	30	0	12	40	1	-	-	-	-	1	1	55
	10	10-8	117	41 36'	81 51'	E.	0930	30	0	45	2	25	70	-	65	-	10	3	220
	11	10-4	97	42 09'	80 29'	SW.	1420	5	3	15	1	3	-	-	-	-	2	-	21
	11	10-5	99	42 06'	80 40'	NW.	0710	20	8	40	30	1	9	-	-	-	20	-	100
	11	10-5	100	42 10'	80 55'	W.	1010	30	0	510	20	-	30	-	-	-	-	-	560
	11	10-5	101	42 10'	81 05'	W.	1140	30	0	640	20	-	19	-	-	-	1	-	680
	11	10-8	118	41 39'	81 54'	W.	1040	30	0	90	15	1	25	-	-	-	5	4	140
	11	10-8	119	41 42'	82 00'	E.	1210	30	0	160	15	15	20	-	-	-	-	-	210
	11	10-8	120	41 47'	82 04'	W.	1340	30	0	80	-	10	15	-	5	-	-	-	110
	12	10-4	96	42 13'	80 28'	SW.	1320	30	0	320	1	1	-	-	-	-	8	-	330
	12	10-5	102	42 07'	81 13'	SW.	1250	30	0	680	-	1	8	-	-	-	1	-	690
	12	10-5	103	42 01'	81 15'	S.	1410	30	0	1,040	3	5	10	-	-	-	2	-	1,060
	12	10-6	105	41 52'	81 17'	W.	1010	30	0	320	32	35	1	-	-	-	10	2	400
	12	10-7	114	41 42'	81 44'	W.	1220	30	0	30	15	36	17	-	1	-	9	2	110
	13	10-6	106	41 55'	81 25'	W.	1130	30	0	290	24	40	2	-	1	-	2	1	360

1/ See footnote 1, app. table 1.

2/ See footnote 2, app. table 1.

Appendix Table 2.—RV *Kaho* fishing log—trawl stations in the Central Basin of Lake Erie.—Continued.

Cruise No.	Depth	Date	Drag No.	Position Lat. N.	Position Long. W.	Course	Time of day	Fished	Limiting factor 1/	Catch: Yellow Perch	Rainbow Smelt	Alewife	Freshwater drum	Carp	Gizzard shad	Channel catfish	White bass	Others 2/	Total
	Fath.	1963						Min.		Pounds									
11	3	5-28	152	41°28'	82°40'	NE.	0930	30	0	7	4	1	49	-	-	6	4	4	75
	4	5-22	125	41°28'	82°38'	N.	1320	30	0	60	100	-	1	-	1	8	7	3	180
	6	5-22	126	41°30'	82°37'	SE	1410	30	0	160	2	-	50	-	-	15	-	3	230
	6	6-6	166	41°59'	80°34'	W.	0550	30	0	140	95	-	2	-	-	-	-	3	240
	7	5-22	127	41°32'	82°34'	NW.	1510	30	0	35	10	-	3	-	-	2	1	4	55
	7	5-24	133	41°35'	82°32'	NE.	1040	30	0	390	5	-	-	-	-	-	-	5	400
	7	5-24	134	41°37'	82°29'	NE.	1140	30	0	300	290	-	-	-	-	-	5	5	600
	7	5-27	148	41°29'	82°15'	W.	0920	5	4	-	-	-	-	-	-	-	-	-	-
	7	6-4	155	41°38'	81°32'	NE.	1230	6	3	14	1	-	-	-	-	-	-	-	15
	7	6-4	156	41°38'	81°32'	NE.	1330	30	0	25	10	-	1	-	-	-	-	-	36
	7	6-16	208	41°33'	82°17'	E.	1050	30	0	9	190	-	10	-	-	-	1	-	210
	8	5-24	137	41°36'	82°16'	E.	1600	30	0	190	180	-	-	-	-	-	-	-	370
	8	6-4	157	41°42'	81°30'	NE.	1430	30	0	270	10	-	-	-	-	-	-	-	280
	9	5-24	136	41°40'	82°12'	W.	1450	30	0	90	14	-	-	5	-	-	1	-	110
	9	5-27	149	41°33'	81°59'	E.	1250	30	0	540	3	-	4	-	-	-	1	2	550
	9	6-5	159	41°50'	81°12'	W.	0720	30	0	410	270	-	-	-	-	-	-	-	680
	9	6-6	167	42°05'	80°27'	NE.	0740	30	0	110	470	-	-	-	-	-	-	-	580
	9	6-13	192	41°59'	80°48'	E.	0530	30	0	6	-	-	15	-	-	-	-	-	21
	9	6-16	209	41°35'	82°02'	E.	1220	30	0	45	50	-	5	-	-	-	-	-	100
	10	5-27	150	41°37'	81°57'	NE.	1330	30	0	60	35	-	-	-	-	-	5	-	100
	10	6-4	158	41°46'	81°28'	NE.	1530	30	0	70	10	-	-	-	-	-	-	-	80
	10	6-13	197	41°50'	80°30'	E.	1420	30	0	9	40	-	1	-	-	-	-	-	50
	10	6-16	211	41°40'	81°57'	S.	1500	30	0	80	110	-	-	-	-	-	-	-	190
	11	5-24	135	41°44'	82°12'	SE.	1350	30	0	80	6	-	-	-	-	-	1	3	90
	11	5-27	151	41°41'	81°52'	NW.	1510	30	0	50	30	-	5	-	-	-	1	4	90
	11	6-5	160	41°55'	81°14'	E.	0830	30	0	1	35	-	-	-	-	-	-	-	36
	11	6-13	193	42°03'	80°46'	W.	0640	30	0	50	220	-	10	-	-	-	-	-	280
	11	6-16	210	41°38'	82°00'	N.	1400	30	0	260	18	-	-	-	-	-	-	2	280
	12	6-5	161	41°59'	81°14'	W.	1000	30	0	60	170	-	-	-	-	-	-	-	230
	12	6-5	162	42°03'	81°14'	E.	1050	30	0	85	25	-	-	-	-	-	-	-	110
	12	6-5	163	42°08'	81°12'	W.	1200	30	0	190	10	-	-	-	-	-	-	-	200
	12	6-5	164	42°13'	80°47'	E.	1450	30	0	240	40	-	-	-	-	-	-	10	290
	12	6-5	165	42°10'	80°45'	W.	1600	30	0	290	30	-	-	-	-	-	-	10	330
	12	6-13	194	42°07'	80°43'	E.	0750	30	0	5	95	-	-	-	-	-	-	-	100
	12	6-13	195	41°59'	80°30'	W.	1200	30	0	5	30	-	-	-	-	-	-	-	35
	12	6-13	196	41°54'	80°32'	E.	1310	30	0	10	200	-	-	-	-	-	-	-	210
	13	6-6	168	42°09'	80°24'	E.	0840	30	0	10	170	-	-	-	-	-	-	-	180
		1966																	
36	5	10-27	278	42°05'	80°15'	E.	1600	30	0	-	-	30	-	-	5	-	1	-	36
	6	10-21	255	41°30'	82°33'	W.	1300	30	0	1	30	30	2	3	40	-	5	3	114
	6	10-24	267	41°47'	81°15'	NE.	1610	16	8	3	120	80	3	-	-	-	4	3	213
	7	10-20	251	41°40'	82°35'	E.	1000	30	0	5	150	350	-	-	10	1	-	2	518
	7	10-20	252	41°38'	82°33'	W.	1100	30	0	10	125	100	5	25	10	1	2	6	284
	7	10-20	253	41°35'	82°35'	W.	1210	30	0	5	50	50	-	35	5	-	2	3	150
	7	10-20	254	41°31'	82°33'	E.	1310	6	2	5	2	2	1	-	1	-	1	-	12
	7	10-21	256	41°41'	82°05'	E.	1540	9	1	1	10	2	-	-	5	-	-	3	21
	8	10-23	261	41°34'	81°42'	E.	1540	30	0	3	60	80	-	-	5	-	1	10	159
	9	10-21	257	41°35'	82°05'	W.	1620	30	0	5	60	40	-	-	10	-	1	6	122
	9	10-27	274	41°59'	80°46'	W.	0750	30	0	-	225	100	-	-	-	-	1	1	327
	10	10-23	258	41°39'	82°06'	E.	0940	30	0	1	25	275	-	-	3	-	1	-	305
	10	10-24	262	41°38'	81°39'	E.	0800	30	0	-	25	225	-	-	10	-	1	-	261
	10	10-26	268	41°52'	81°17'	E.	0740	30	0	2	125	200	-	10	-	-	-	1	338
	11	10-23	259	41°43'	82°04'	W.	1050	30	0	5	50	250	-	-	-	-	5	-	310
	11	10-23	260	41°46'	82°06'	E.	1210	30	0	-	30	150	-	-	2	-	3	-	185
	11	10-24	263	41°44'	81°37'	E.	0910	30	0	-	50	200	-	-	3	-	2	-	255
	11	10-27	276	42°15'	80°22'	W.	1340	24	8	-	10	80	-	-	-	-	-	-	90
	12	10-24	264	41°49'	81°39'	E.	1030	30	0	1	80	200	-	-	30	-	-	-	311
	12	10-26	269	41°56'	81°17'	W.	0850	30	0	3	75	250	-	-	-	-	1	-	329
	12	10-26	272	42°12'	80°50'	E.	1420	30	0	30	75	175	-	-	-	-	-	-	280
	12	10-26	273	42°08'	80°48'	W.	1530	30	0	1	150	200	-	-	-	-	-	-	351
	12	10-27	275	42°04'	80°48'	E.	0900	30	0	1	50	200	-	-	-	-	2	-	253
	13	10-24	265	41°53'	81°37'	W.	1140	30	0	-	25	220	-	-	5	-	-	-	250
	13	10-26	270	42°00'	81°17'	E.	1010	30	0	10	10	340	-	-	-	-	2	-	362
	13	10-26	271	42°05'	81°15'	W.	1120	30	0	1	10	265	-	-	-	-	-	-	276
	13	10-27	277	42°10'	80°23'	E.	1500	27	8	-	20	160	-	-	-	-	-	-	180
	13	10-24	266	41°58'	81°39'	E.	1310	30	0	-	10	200	-	-	-	-	-	-	210

1/ See footnote 1, app. table 1.

2/ See footnote 2, app. table 1.

Appendix Table 3.—RV *Kaho* fishing log—trawl stations in the Eastern Basin of Lake Erie.

Cruise	Depth	Date	Drag	Position		Course	Time of Day	Fished	Limiting factor[1]	Catch								
				Lat. N.	Long. W.					Yellow perch	Rainbow Smelt	Alewife	Freshwater drum	Carp	Gizzard shad	Channel catfish	White bass	Others[2]	Total
	Fath.	1962						Min.		Pounds									
	5	5-4	8	42°47'	78°54'	W.	1310	30	0	-	1	-	-	-	-	-	-	-	1
	6	5-4	7	42°49'	78°57'	NE.	1050	30	0	-	10	-	1	-	-	-	-	2	13
	6	5-4	9	42°44'	79°00'	W.	1410	30	0	1	55	-	-	-	-	-	-	-	56
	13	5-5	11	42°41'	79°17'	SE.	1010	30	0	-	2	-	-	-	-	-	-	-	2
	14	5-5	14	42°29'	79°29'	NE.	1540	30	0	1	11	-	-	-	-	-	-	3	15
	15	5-5	10	42°34'	79°19'	NE.	0830	30	0	1	2	-	-	-	-	-	-	-	3
	15	5-7	19	42°21'	79°49'	E.	1830	30	2	1	3	-	1	-	-	-	-	1	6
	17	5-5	12	42°37'	79°27'	SE.	1250	30	0	-	2	-	-	-	-	-	-	2	4
	18	5-7	13	42°26'	79°50'	E.	1640	30	0	3	5	-	-	-	-	-	1	-	9
	27	5-10	18	42°17'	80°43'	SW.	1310	30	0	1	2	-	-	-	-	-	-	-	3
	30	5-7	15	42°31'	79°45'	E.	0730	30	0	2	8	-	-	-	-	-	-	-	10
	30	5-7	16	42°33'	79°39'	W.	0950	30	0	1	2	-	-	-	-	-	-	-	3
	30	5-7	17	42°34'	79°36'	SW.	1350	30	0	2	12	-	-	-	1	-	-	-	15
		1962																	
	10	10-1	77	42°32'	79°18'	NE.	0610	30	0	-	15	-	2	8	-	-	1	3	29
	10	10-1	84	42°31'	79°22'	NE.	1520	30	0	5	1	-	-	38	-	-	1	10	55
	11	10-1	80	42°42'	79°09'	NE.	0940	30	0	6	3	8	-	-	-	-	-	13	30
	12	10-1	79	42°39'	79°14'	NE.	0830	30	0	5	80	2	-	-	-	-	-	3	90
	12	10-1	83	42°32'	79°25'	E.	1440	30	0	10	1	5	-	-	-	-	15	-	31
	12	10-4	94	42°14'	80°07'	W.	0940	30	0	8	80	1	-	-	-	-	1	-	90
	13	10-2	90	42°21'	79°41'	NE.	1310	30	0	1	600	8	-	-	-	-	1	-	610
	14	10-3	91	42°17'	80°00'	E.	1310	30	0	170	150	2	-	-	-	-	3	5	330
	15	10-1	78	42°36'	79°19'	NE.	0730	30	0	2	380	4	-	-	-	-	-	4	390
	15	10-2	85	42°32'	79°41'	W.	0630	30	0	4	30	1	-	-	-	-	1	1	37
	16	10-1	81	42°36'	79°24'	W.	1210	30	0	11	200	4	-	-	-	-	5	-	220
	19	10-1	82	42°34'	79°28'	NW.	1310	30	0	4	490	3	-	-	-	-	3	-	500
	19	10-2	89	42°23'	79°40'	SW.	1210	30	0	5	450	5	-	-	-	-	-	-	460
	19	10-3	92	42°21'	80°00'	W.	1430	30	0	-	1,120	1	-	-	-	-	-	19	1,140
	20	10-2	88	42°24'	79°40'	N.	1100	30	0	10	480	-	-	-	-	-	-	-	490
	21	10-2	87	42°26'	79°42'	E.	0940	30	0	10	300	-	-	-	-	-	-	-	310
	23	10-3	93	42°25'	79°59'	NE.	1610	30	0	10	120	-	-	-	-	-	-	-	130
	25	10-2	86	42°32'	79°40'	S.	0820	30	0	10	150	-	-	-	-	-	-	-	160
		1963																	
	9	6-7	170	42°14'	80°01'	E.	1000	6	8	1	1	-	-	-	-	-	-	-	2
	9	6-10	186	42°40'	79°08'	NE.	1110	30	0	4	350	-	-	-	-	-	1	5	360
	9	6-10	187	42°43'	79°06'	NE.	1210	30	0	10	380	-	-	-	-	-	-	-	390
	10	6-9	178	42°18'	79°46'	NE.	0850	30	0	3	90	-	-	-	-	-	-	2	95
	10	6-10	191	42°32'	79°22'	SE.	1630	30	0	4	250	-	-	-	-	-	-	6	260
	11	6-6	169	42°13'	80°15'	E.	0940	30	0	1	1	-	-	-	-	-	-	-	2
	11	6-10	190	42°32'	79°24'	E.	1550	30	0	10	180	-	-	-	-	-	-	-	190
	12	6-8	174	42°17'	80°15'	W.	0910	30	0	30	50	-	-	-	-	-	-	5	85
	12	6-10	185	42°39'	79°13'	NE.	1000	30	0	1	30	-	-	-	-	-	-	4	35
	13	6-10	188	42°38'	79°13'	W.	1350	30	0	-	90	-	-	-	-	-	-	5	95
	14	6-8	175	42°19'	80°16'	E.	1010	30	0	75	25	-	-	-	-	-	-	-	100
	15	6-7	171	42°17'	79°59'	E.	0940	15	9	9	200	-	-	-	-	-	-	1	210
	15	6-7	172	42°18'	79°58'	W.	1020	30	0	1	550	-	-	-	-	-	-	9	560
	15	6-9	179	42°21'	79°44'	E.	0940	30	0	5	150	-	-	-	-	-	-	5	160
	15	6-10	184	42°38'	79°24'	E.	0830	30	0	1	35	-	-	-	-	-	-	-	36
	15	6-10	189	42°35'	79°22'	E.	1500	30	0	-	80	-	-	-	-	-	-	-	80
	16	6-8	176	42°21'	80°14'	W.	1110	30	0	10	80	-	-	-	-	-	-	-	90
	18	6-8	177	42°22'	80°13'	E.	1210	30	0	20	30	-	-	-	-	-	-	-	50
	18	6-9	180	42°21'	79°46'	E.	1030	30	0	-	250	-	-	-	-	-	-	10	260
	20	6-9	181	42°22'	79°44'	SW.	1120	30	0	10	180	-	-	-	-	-	-	-	190
	22	6-7	173	42°24'	80°00'	E.	1150	30	0	50	50	-	-	-	-	-	-	-	100
	24	6-9	182	42°27'	79°46'	NE.	1230	30	0	1	25	-	-	-	-	-	-	-	26
	32	6-9	183	42°31'	79°44'	SW.	1350	30	0	1	20	-	-	-	-	-	-	-	21
		1966																	
	5	10-30	279	42°12'	80°00'	E.	0800	24	8	-	10	-	-	-	1	-	1	1	13
	10	10-30	280	42°17'	79°58'	NE.	0910	30	0	-	200	10	-	-	1	-	1	-	212
	15	10-30	281	42°18'	80°01'	NE.	1010	30	0	-	70	160	-	-	5	-	-	-	235
	20	10-30	282	42°23'	79°56'	E.	1120	30	0	2	325	75	-	-	-	-	-	1	403
	25	10-30	284	42°33'	79°37'	SW.	1440	30	0	2	115	35	-	-	-	-	-	-	152
	30	10-30	283	42°31'	79°39'	E.	1600	30	0	1	100	10	-	-	-	-	-	-	111

1/ See footnote 1, app. table 1.

2/ See footnote 2, app. table 1.

Appendix Table 4.—Species composition of 56 trawl catches by RV *Kaho* in Lake Erie during Cruise 2, May 1962.

Species	Total catch		Occurrence in total catch		Average catch rate per 1/2 hr effort	Effective catch rate per 1/2 hr effort
	Pounds	Percent 1/	Number	Percent	Pounds 1/	Pounds
Yellow perch (Perca flavescens)	1,217	64.6	36	64.3	21.7	33.8
Rainbow smelt (Osmerus mordax)	530	28.1	53	94.6	9.5	10.0
Freshwater drum (Aplodinotus grunniens)	51	2.7	13	23.2	.9	3.9
White bass (Roccus chrysops)	36	1.9	11	19.6	.6	3.3
Spottail shiner (Notropis hudsonius)	16	.8	12	21.4	.3	1.3
White sucker (Catostomus commersoni)	9	.5	4	7.1	.2	2.2
Trout-perch (Percopsis omiscomaycus)	7	.4	7	12.5	.1	1.0
Channel catfish (Ictalurus punctatus)	5	.3	3	5.4	T	1.7
Lake whitefish (Coregonus clupeaformis)	4	.2	2	3.6	T	2.0
Burbot (Lota lota)	2	.1	1	1.8	T	2.0
Emerald shiner (Notropis atherinoides)	2	.1	2	3.6	T	1.0
Carp (Cyprinus carpio)	1	T	1	1.8	T	1.0
Walleye (Stizostedion vitreum vitreum)	1	T	1	1.8	T	1.0
Gizzard shad (Dorosoma cepedianum)	1	T	1	1.8	T	1.0
Black bullhead (Ictalurus melas)	1	T	1	1.8	T	1.0
Smallmouth bass (Micropterus dolomieui)	1	T	1	1.8	T	1.0
Sea lamprey (Petromyzon marinus)	1	T	1	1.8	T	1.0
TOTALS	1,885				33.3	

1/ T = Trace, less than 0.1.

Appendix Table 5.—Species composition of 55 trawl catches by RV *Kaho* in Lake Erie during Cruise 4, September 1962.

Species	Total catch		Occurrence in total catch		Average catch rate per 1/2 hr effort	Effective catch rate per 1/2 hr effort
	Pounds	Percent 1/	Number	Percent	Pounds 1/	Pounds
Yellow perch (*Perca flavescens*)	6,647	43.5	51	92.7	125.4	135.7
Rainbow smelt (*Osmerus mordax*)	5,179	33.9	45	81.8	97.7	120.4
Carp (*Cyprinus carpio*)	1,114	7.3	14	25.4	21.0	85.0
Alewife (*Alosa pseudoharengus*)	654	4.3	42	76.4	12.3	16.0
Gizzard shad (*Dorosoma cepedianum*)	637	4.2	23	41.8	12.0	28.8
Freshwater drum (*Aplodinotus grunniens*)	486	3.2	29	52.7	9.2	16.9
White bass (*Roccus chrysops*)	264	1.7	37	67.3	5.0	7.5
Channel catfish (*Ictalurus punctatus*)	91	.6	11	20.0	1.7	9.0
Walleye (*Stizostedion vitreum vitreum*)	46	.3	13	23.6	.9	3.5
Goldfish (*Carassius auratus*)	25	.2	1	1.8	.5	2.5
Spottail shiner (*Notropis hudsonius*)	25	.2	19	34.5	.5	1.4
Emerald shiner (*Notropis atherinoides*)	16	.1	13	23.6	.3	1.4
Trout-perch (*Percopsis omiscomaycus*)	15	.1	15	27.3	.3	1.0
Lake whitefish (*Coregonus clupeaformis*)	15	.1	1	1.8	.3	1.5
Burbot (*Lota lota*)	14	T	4	7.3	.3	3.5
Sauger (*Stizostedion canadense*)	13	T	1	1.8	.2	1.3
White sucker (*Catostomus commersoni*)	10	T	5	9.1	.2	.5
Quillback (*Carpiodes cyprinus*)	7	T	2	3.6	.1	3.5
Stoneroller (*Campostoma anomalum*)	3	T	3	5.4	T	.1
Black bullhead (*Ictalurus melas*)	2	T	2	3.6	T	.1
White crappie (*Pomoxis annularis*)	1	T	1	1.8	T	.1
Sea lamprey (*Petromyzon marinus*)	1	T	1	1.8	T	.1
TOTALS	15,265				288.0	

1/ T = Trace, less than 0.1.

Appendix Table 6.—Species composition of 87 trawl catches by RV *Kaho* in Lake Erie during Cruise 11, May 1963.

Species	Total catch		Occurrence in total		Average catch rate per 1/2 hr effort	Effective catch rate per 1/2 hr effort
	Pounds	Percent 1/	Number	Percent	Pounds 1/	Pounds
Yellow perch (*Perca flavescens*)	7,398	38.5	83	95.4	88.9	92.4
Rainbow smelt (*Osmerus mordax*)	6,241	32.5	75	86.2	75.0	84.7
Freshwater drum (*Aplodinotus grunniens*)	2,890	15.0	39	44.8	34.7	75.6
Carp (*Cyprinus carpio*)	1,182	6.2	16	18.4	14.2	77.8
Channel catfish (*Ictalurus punctatus*)	641	3.3	23	26.4	7.7	28.9
White bass (*Roccus chrysops*)	244	1.3	36	41.4	2.9	6.9
Alewife (*Alosa pseudoharengus*)	154	.8	16	18.4	1.8	9.6
Walleye (*Stizostedion vitreum vitreum*)	145	.7	25	28.7	1.7	5.8
Emerald shiner (*Notropis atherinoides*)	82	.4	16	18.4	1.0	5.1
White sucker (*Catostomus commersoni*)	53	.3	20	23.0	.6	2.7
Spottail shiner (*Notropis hudsonius*)	46	.2	31	35.6	.5	1.5
Burbot (*Lota lota*)	42	.2	7	8.0	.5	6.0
Trout-perch (*Percopsis omiscomaycus*)	29	.1	19	21.8	.3	1.6
Black bullhead (*Ictalurus melas*)	15	T	7	8.0	.2	2.2
Lake herring (*Coregonus artedii*)	15	T	2	2.3	.2	7.5
Sauger (*Stizostedion canadense*)	10	T	1	1.1	.1	10.0
Goldfish (*Carassius auratus*)	4	T	2	2.3	T	2.0
Lake whitefish (*Coregonus clupeaformis*)	3	T	2	2.3	T	1.5
Buffalo (*Ictiobus* sp.)	2	T	2	2.3	T	1.1
Stonecat (*Noturus flavus*)	2	T	2	2.3	T	1.3
Gizzard shad (*Dorosoma cepedianum*)	1	T	1	1.1	T	1.0
Stoneroller (*Campostoma anomalum*)	1	T	1	1.1	T	1.0
Pumpkinseed (*Lepomis gibbosus*)	1	T	1	1.1	T	1.0
Sea lamprey (*Petromyzon marinus*)	1	T	1	1.1	T	1.0
TOTAL	19,202				230.3	

1/ T = Trace, less than 0.1.

Appendix Table 7.—Species composition of 47 trawl catches by RV *Kaho* in Lake Erie during Cruise 36, October 1966.

Species	Total catch		Occurrence in total catch		Average catch rate per 1/2 hr effort	Effective catch rate per 1/2 hr effort
	Pounds	Percent 1/	Number	Percent	Pounds 1/	Pounds
Alewife (*Alosa pseudoharengus*)	6,392	54.4	46	97.9	143.6	146.3
Rainbow smelt (*Osmerus mordax*)	2,810	23.9	46	97.9	63.1	64.6
Carp (*Cyprinus carpio*)	642	5.5	16	34.0	14.4	40.1
Gizzard shad (*Dorosoma cepedianum*)	577	4.9	30	63.8	13.0	20.4
Goldfish (*Carassius auratus*)	418	3.5	5	10.6	9.4	83.6
Freshwater drum (*Aplodinotus grunniens*)	282	2.4	16	34.0	6.3	19.2
Channel catfish (*Ictalurus punctatus*)	207	1.8	8	17.0	4.6	25.9
Yellow perch (*Perca flavescens*)	193	1.6	33	70.2	4.3	6.2
White bass (*Roccus chrysops*)	110	.9	30	63.8	2.5	3.8
Spottail shiner (*Notropis hudsonius*)	51	.4	18	38.3	1.1	3.0
Walleye (*Stizostedion vitreum vitreum*)	37	.3	11	23.4	.8	4.6
Quillback (*Carpiodes cyprinus*)	23	.2	5	10.6	.5	4.8
White sucker (*Catostomus commersoni*)	6	T	5	10.6	.1	1.2
Stonecat (*Noturus flavus*)	2	T	2	4.2	T	1.0
Yellow bullhead (*Ictalurus natalis*)	2	T	2	4.2	T	1.0
Trout-perch (*Percopsis omiscomaycus*)	2	T	2	4.2	T	1.0
Rock bass (*Ambloplites rupestris*)	1	T	1	2.1	T	2.0
White crappie (*Pomoxis annularis*)	1	T	1	2.1	T	3.3
Black bullhead (*Ictalurus melas*)	1	T	1	2.1	T	1.0
Longnose gar (*Lepisosteus osseus*)	1	T	1	2.1	T	1.0
Logperch (*Percina caprodes*)	1	T	1	2.1	T	1.2
TOTALS	11,759				263.7	

1/ T = Trace, less than 0.1.

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